Nonproliferation and Arms Control Technology Working Group Report, 1997-98 Executive Summary

Submitted to

the National Security Council and the Committee on National Security on Coordination of Nonproliferation and Arms Control Research and Development

Submitted by

The Co-Chairs of the Nonproliferation and Arms Control Technology Working Group

SARAH MULLEN
Chief, Intelligence, Technology, and Analysis Division,
Bureau of Intelligence, Verification and Information Management
U.S. Arms Control and Disarmament Agency

WALTER BUSBEE
Deputy Assistant to the Secretary of Defense
for Counterproliferation and Chemical/Biological Defense

ROBERT WALDRON
Director, Office of Research and Development
Office of Nonproliferation And National Security
U.S. Department of Energy

May 20, 1999

Classified By: Multiple Sources
Reason: 1.5 (e) X2
Declassify On: 10/9/23

Table of Contents

Executive Summary (U)

The Nonproliferation and Arms Control Technology Working Group (NPAC TWG) was established in 1994 by Presidential Decision Directive 27 (PDD-27) to serve as the Executive Branch's mechanism for coordinating arms control and nonproliferation technology research and development (R&D). The President designated the Arms Control and Disarmament Agency (ACDA), the Office of the Secretary of Defense (OSD), and the Department of Energy (DOE) as co-chairs of the NPAC TWG. ACDA serves as executive secretary. The NPAC TWG is chartered to review NPAC-related R&D programs within and among US departments and agencies with a view to identifying gaps and resolving unnecessary overlaps in these programs. Since its inception, the NPAC TWG has brought together over 25 agencies and organizations on its formal membership roll. Also, numerous other organizations have been included in the proceedings of the NPAC TWG and its focus groups. (U)

This is the fourth annual NPAC TWG report to the National Science and Technology Council's (NSTC) Committee on National Security (CNS) and the National Security Council (NSC). The report summarizes the 1997-98 activities of the NPAC TWG. It also discusses the NPAC TWG's recommendations and plans for dealing with key R&D coordination issues identified over the four year course of NPAC TWG efforts. Together with PDD-27 and the NPAC TWG charter (See Appendix A), this report should be used as a reference and planning tool for departments and agencies that perform or require technology R&D serving NPAC purposes. (U)

This unclassified executive summary is intended for wide distribution, discussion, and implementation as appropriate throughout the R&D and policy communities. (U)

The Need for Coordination (U)

As articulated in the President's National Security Science and Technology Strategy (1995), the US must pursue a robust and focused science and technology strategy that applies technical knowledge to the development of effective arms restraints; that continually improves detection, monitoring and verification capabilities; and that emphasizes science and technology cooperation. The obligations and challenges facing the US Government (USG) in the nonproliferation and arms control fields continue to grow. The improved tools and technologies needed to meet these challenges in the future can only emerge from today's technology R&D programs. Despite the importance of these R&D challenges, the resources needed to meet them are severely limited. Moreover, funding is likely to remain tightly constrained for the foreseeable future. (U)

The critical tasks facing the USG are to foster better planning of technology R&D across the arms control and nonproliferation communities, and to enhance execution of R&D programs with an eye toward more efficient stewardship of the technical and financial resources available. Since there is no central management of technology R&D in the USG, that is, no government-wide "Department of Science and Technology", the R&D

process must be self-governing. The underlying philosophy of the NPAC TWG is to facilitate such a process. (U)

The NPAC TWG functions through the Technology Needs Subcommittee (TNS) that identifies and coordinates current and future NPAC technology needs, as well as through the following thirteen focus groups that are organized by technology, function, or arms control treaty area:

- Active Electro-Optics
- Ballistic Missile Sensors
- Biological Weapons Detection
- Chemical Weapons Detection
- Fieldable Nuclear Detectors
- Fissile Materials Monitoring
- Landmine Detection and Identification
- Nuclear Test Monitoring
- Proliferation Modeling
- R&D Database
- Spectral Sensing
- Unattended Remote Sensors
- Underground Facilities (U)

These groups draw on the regular and frequent participation of over one hundred government R&D program managers. (U)

After four years in operation, the NPAC TWG is acknowledged widely to have fostered substantial improvements in the coordination of federal R&D. The main challenge today is for the NPAC TWG to build on its track record and credibility and, without jeopardizing the cooperative spirit of this effective interagency process, aggressively execute the full scope of its charter. (U)

1997-98 NPAC TWG Activities (U)

Through its coordination efforts, the NPAC TWG strives to assure participating agencies, Congress, and ultimately the American public that federal technology R&D programs are meeting NPAC needs. The NPAC TWG also provides technology and budget crosscuts for policy and acquisition decision makers that help them make better resource allocation decisions. (U)

Since submitting its last report, the NPAC TWG has completed the following:

- Presented briefings for a variety of agencies, groups, and key individuals with an interest in NPAC matters, including the following:
  - The White House Office of Science and Technology Policy;
  - The NSTC's Committee on National Security;
  - The Office of Management and Budget;

  - The Counterterrorism Technology Support Working Group;
  - The National Security Council Special Assistants for Intelligence, and Nonproliferation and Export Control;
  - The Director of the Office of Research and Development, Central Intelligence Agency; and
  - Representatives of various Congressional staffs including the Senate and House Armed Services Committees;
- Conducted the Third Annual Symposium on Nonproliferation and Arms Control Research and Development on October 22-23, 1997, which consisted of reports of the focus groups to the NPAC TWG members and, for the first time, a second day for interactive technical breakout sessions. The Symposium was attended by approximately 300 R&D managers, contractors, other members of the NPAC R&D community, and some policy makers;
- Expanded cooperation with the Counterproliferation Program Review Committee (CPRC), most notably through the joint establishment of working groups for hazard prediction models, unattended ground sensors and hyper/ultraspectral sensors for CW/BW detection;
- Continued to ensure the effective coordination of 282 R&D programs and projects identified for arms control and nonproliferation that collectively account for over $600 million of the annual federally funded NPAC technology R&D budget;
- Further refined processes for identifying and validating NPAC technology needs that would benefit from appropriate R&D, identifying the technology drivers that most influence whether the US can achieve its NPAC technology R&D goals in the future, and providing a community-validated list of each of these needs and drivers;
- Renamed the START Focus Group as the Ballistic Missile Sensors Focus Group and recast the charter of this group to address US readiness to deal with arms control and nonproliferation ballistic missile-related problems identified by the TNS;
- Continued to update the classified and unclassified NPAC TWG web pages as mechanisms for electronic data exchange with the widest possible community interested in arms control and nonproliferation R&D issues, and to improve their usefulness using DoD's Technology Navigator; and
- Expanded tasking of a Federally Funded Research and Development Center (FFRDC) to support the NPAC TWG by gathering and organizing relevant information, performing selected studies, and supporting several focus groups. (U)

Four Year Perspective on the NPAC TWG (U)

The successful pursuit of new and ongoing technology initiatives in arms control and nonproliferation requires vigorous and creative R&D programs that efficiently capitalize on the available resources through government-wide coordination and cooperation. The NPAC TWG is an appropriate vehicle for achieving this goal and, as noted earlier, ideally

would embody the self-governing process for improved collaborative program planning and execution. However, after four years of developing an effective coordinating process for federal NPAC technology programs within traditional acquisition structures, it is apparent that new approaches to debating and adjudicating recurring R&D program issues may be needed to fulfill the full scope of the NPAC TWG charter. (U)

The NPAC TWG focus groups, comprised in large measure of those who direct the research, are relied upon to make recommendations to resource managers on significant gaps and wasteful overlaps. For the most part, this process works well for issues and recommendations clearly related to the missions and priorities of the involved agencies. Without detracting from the notable successes of the NPAC TWG, the membership is beginning to recognize that within the NPAC TWG charter there are inherent limits to what can be achieved cooperatively among federal agencies, as each has distinct missions, time horizons, funding lines, and acquisition processes that often drive unique technology programs. (U)

BOUNDING THE PROBLEM (U)

While the NPAC TWG Charter is specific on the subject of developing recommendations, it is not specific on ways to operationalize them. It is in the nature of bureaucratic processes that one will not risk higher priority programs or expend scarce resources for the common good if there is no compelling mandate or obvious reward. Hence, if there is a recognized need in our national NPAC technology objectives that falls outside the mission of any single agency or does not rank successfully within agency budget processes, that need can be left unfulfilled. Under these conditions, even a well-coordinated consortium of agencies cannot mitigate a technology gap without independent authority or funding discretion that is non-prejudicial to their mission-specific programmatic funding. (U)

This problem bears directly on two important elements of the NPAC TWG charter. The first involves advising agencies on arms control and nonproliferation technology priorities. The second concerns framing interagency issues and differences for decisions by adjudicating bodies. (U)

The individual program managers and technologists forming the NPAC TWG cannot be expected to go outside their chains of command to garner support for their recommendations or to necessarily have the "macro" view of agencies' R&D priorities. Obviously, the NPAC TWG can not presume to prioritize agency R&D programs. At the same time, the program managers and technology developers cannot be expected to respond to perceived needs unless there is concurrent indication of policy support. (U)

Without creating new structures or threatening agency prerogatives, one approach to improving the NPAC TWG process should be to use this report to expand the dialog into the national security policy, technology developer, and user communities. (U)

OPPORTUNITIES FOR IMPROVEMENT (U)

Approaches to alleviating these problems would avoid redirecting funds and introducing new authority structures. With the view that the sources of these problems are as much sociological as they are structural, the NPAC TWG membership believes that more spirited participation by technology users and policy makers is needed to accomplish the following:

- Ensure a suitably broad dialog across government,
- Open the coordination process to more programs and organizations, and
- Ensure technological approaches to national security problems are responding to real policy and operational needs. (U)

Successfully addressing NPAC TWG recommendations will require a broader awareness and appreciation of issues in the following three areas: engaging a wider range of participants, examining a wider range of programs, and moving technologies from R&D to operational status. (U)

Engaging A Wider Range Of Participants (U)

The first dimension to improving coordination is finding better ways to engage policy makers, technology users, and technology developers in the continuing dialog on the relationship between technical needs and R&D programs. This dialog must include national policy directions and priorities. It also must be specific and continuous because the participants otherwise are responding to different pressures, requirements, and deadlines from one another and do not have a common forum in which to meet. The goals of this dialog are to accomplish the following (U):

- Overcome the historical tendency for the NPAC policy community to rely somewhat blithely on the R&D community to anticipate long-term operational NPAC needs. R&D program planning with insufficient policy guidance or involvement can lead to a higher degree of "technology push" than desirable. (U)
- Provide sufficient interaction between today's developers and the future users of key technologies at stages in the R&D planning process when the insights of the latter can influence the plans and decisions of the former. Understanding R&D product customers' expectations is crucial to delivering what is needed, especially where one department or agency may be developing products for another. (U)
- Provide the policy community with a clear understanding of the doable, the achievable, and the not-yet-possible. (U)

Examining A Wider Range Of Programs (U)

The second dimension is broadening the range of R&D programs considered by the NPAC TWG. The NPAC TWG focus groups examined 282 R&D programs that accounted for almost $600 million (see Section 2). Both the number and dollar value of these programs have grown steadily over the past four years. This is a notable success from a program coordination viewpoint. (U)

Many R&D programs are developed and justified in terms of a single agency or department mandate. Yet the results of R&D are often unpredictable. R&D programs often produce results more widely useful than, or significantly different from, what is expected. Moreover, NPAC programs typically are compartmented at all levels, so R&D results often are not widely shared, even among agencies with similar missions, and, in some instances, even within the same agencies. For these and other reasons, R&D potentially useful for NPAC purposes is not limited to programs or organizations with clear NPAC-related mandates. (U)

Table E-1 illustrates this point. The table shows unclassified agency and department aggregate funding for R&D programs that focus on technologies potentially relevant to the NPAC community. This table suggests that it is essential for NPAC TWG member organizations to examine the R&D activities even of agencies or departments with missions wholly unrelated to nonproliferation and arms control, or within agencies which are reluctant to become associated with what they perceive to be "intelligence" programs. (U)

Table E-1. R&D BUDGET AUTHORITY WITH POSSIBLE ARMS CONTROL OR NONPROLIFERATION APPLICATIONS[1] (U)
(THOUSANDS OF $US)

DEPARTMENT OR AGENCY[2]	FISCAL YEAR 1997	PERCENTAGE OF TOTAL
COMMERCE	$238,728	3.9%
DEFENSE	$3,257,617	52.9%
ENERGY	$735,023	11.9%
ENVIRONMENTAL PROTECTION AGENCY	$508,482	8.25%
HEALTH AND HUMAN SERVICES	$60,633	0.98%
JUSTICE	$2,000	0.03%
NASA	$586,600	9.5%
NATIONAL SCIENCE FOUNDATION	$720,080	11.69%
TRANSPORTATION	$41,397	0.67%
TREASURY	$11,000	0.18%
TOTAL	**$6,161,560**	**100%**

(U)

[1] Source: The Radius Database of Federal R&D Expenditures. Radius is a comprehensive database that tracks the funding invested annually by the US Government in R&D, from the top level of the federal agencies that fund R&D work to the thousands of sites where the work is performed. Radius was developed by RAND in cooperation with the NSF. (U)

The R&D Budget Authority represents the total R&D funding controlled by a specific organization. In a given department or agency, the entire amount is not devoted necessarily to R&D purposes. Classified budget totals do not appear in Radius. (U)

[2] Methods: Radius identified thousands of individual R&D programs that matched a set of the NPAC-related key words. The identified programs were reviewed by title and sponsoring agency to eliminate programs clearly irrelevant to NPAC purposes, while the remaining programs were included in the table as potential sources of R&D useful for NPAC purposes. (U)

On the other hand, Table E-1 seems to indicate a large gap exists between the programs captured by the NPAC TWG and the potentially relevant R&D conducted across government. Many R&D programs embedded in Table E-1 remain wholly unexplored for their applicability to NPAC purposes. Unfortunately, it is not within the resources of the NPAC TWG to examine the thousands of potentially relevant R&D programs that comprise Table E-1. (U)

Moving Technologies from R&D to Operational Status (U)

It is often difficult for technology developers to obtain the resources needed to take newly identified technologies to a level of maturity at which users can implement them readily. Users of NPAC technologies also face their own budget constraints and are often reluctant to invest scarce operational resources and risk manpower in anything but proven technologies. This problem is often compounded when a single agency can neither invest sufficiently in a technology that would benefit multiple agencies nor collaborate effectively with other agencies in such investments. This results in persistent shortfalls in cross-cutting and wide-ranging national needs. (U)

The developer-user "gap" is often evidenced by the following :

- The tendency of the resource allocation process to be loosely connected with, or even disconnected from, the requirements definition process in some agencies performing NPAC technology R&D;
- Weak incentives for long-range planning and requirements definition, resulting in a short-term focus on enhancements of proven technologies at the expense of long-term, perhaps higher risk R&D that could yield major gains; and
- Special purpose, single agency-specific programs of limited technical scope or narrow application. (U)

Consequently, opportunities for cross-fertilization of ideas and the development of multiple-use technologies available to all agencies and departments are frequently foregone. (U)

ELEMENTS OF AN ENHANCED NPAC TWG PROCESS (U)

The NPAC TWG charter is broad and ambitious. Experience over the past four years has led to a more refined view of the coordination needed for NPAC technology R&D programs. The problems discussed above can be made more tractable through expanded participation across government on multiple fronts – specifically the policy, R&D and operations elements of all organizations. The expanded dialog envisioned by the NPAC TWG has the following elements:

- Continuing, but improved, coordination among policy officials, NPAC technology users, and NPAC-related technology developers on the subject of technical capabilities needed in the future through more frequent, carefully focused discussion;

- Improved identification of interagency-coordinated national level priorities for NPAC technologies that could lay out a road map to the future capabilities that will be needed;
- Continued, but increased, collaboration between the CPRC and the NPAC TWG on issues of joint concern;
- Increased NPAC TWG dialog with the CNS and the National Security Council to engage the national level policy community more fully in the R&D process in a selective way, and to communicate national needs to agencies via CNS;
- Careful exploration of R&D programs sponsored by agencies that do not have NPAC-related mandates but may be producing technologies of possible use in achieving NPAC purposes; and
- Increased awareness within the policy community of the activities within the R&D community. (U)

Overall NPAC TWG Recommendations (U)

The NPAC TWG has accomplished much in its first four years, but the need to improve the coordination of NPAC-related R&D remains. Building upon its successes, the NPAC TWG will attempt to improve its ability to perform the necessary coordination by:

- Strengthening the role of the TNS by assigning it responsibility for identifying more completely the future needs for NPAC technologies; improving the linkage between the needs of the NPAC policy community and the technology development programs carried out within the R&D community; and documenting these links in a widely accessible form for use by the R&D community in planning and justifying its programs;
- Using the links between the NPAC TWG and the CNS as a means of improving information sharing concerning the needs of the policy community, the operational user community, and the R&D community;
- Engaging the R&D principals of the agencies comprising the NPAC TWG membership more extensively by framing issues that cannot resolved at the NPAC TWG level for action by a higher level adjudicating body; using their influence to obtain decisions from this body with respect to programs deemed under-funded or otherwise endangered; and
- Broadening links with R&D managers in Departments and Agencies not typically viewed as having NPAC mandates with a goal of determining whether R&D sponsored by these organizations has, or can have, NPAC applications. (U)

TECHNOLOGY NEEDS SUBCOMMITTEE RECOMMENDATIONS (U)

The Technology Needs Subcommittee (TNS) recommends that the TNS accomplish the following over the next year:

1. Work more closely with threat analysts working in the IC and elsewhere to identify key technology-based future threats as a means of identifying R&D that will support

future arms limitation agreements and respond more effectively to future proliferation threats;

2. Work with the NPAC TWG focus groups to identify and develop more quantitative descriptions of the technology needs and drivers for technology developers to use in planning and carrying out their programs;
3. Develop and implement a means for monitoring progress in the key technology areas identified in this report; and
4. Improve communications with community resource, technology, and R&D managers to provide more effective guidance for R&D investments and programs that support NPAC missions. (U)

Several themes emerge from these recommendations. First, improvements should be made in establishing the link between technology needs on the one hand, and specific R&D recommendations on the other. Second, improved methods should be developed for identifying the appropriate recipients for the recommendations, for determining the disposition of these recommendations, for monitoring and tracking progress with respect to their implementation, for adjudicating conflicts among them, and for determining the benefits that result. Third, communication of all this information to NPAC community organizations and participants should be improved by identifying the cognizant parties, reviewing the charters of the interagency groups involved, developing Memoranda Of Understanding (MOUs) as needed, and proposing means to achieve joint goals. (U)

An alarming trend has become apparent in FY98: Resources are declining for basic research. As funds shrink, resource managers grow less tolerant of R&D investments that are not linked directly to an operational need. Thus funds needed for basic discovery, innovation in fundamental thinking, and new ideas are being allocated and managed in accordance with a constricted set of policy needs and demands. The consequences are loss of capability in research centers; loss of skills and decline in talent among individual researchers; a reduced reservoir of available technology; and a lack of capability for achieving technological solutions. (U)

KEY FOCUS GROUP RECOMMENDATIONS (U)

Section 2 of the classified report provides summaries of each focus group's annual report to the NPAC TWG, including findings and recommendations. Many of these recommendations are highly specific to a given focus group's area, and many cannot be included in this unclassified summary. The following unclassified recommendations are based on NPAC TWG findings that apply across agencies, technical disciplines, and functional areas. (U)

Some of these recommendations appeared in previous NPAC TWG Annual Reports. These recommendations appear again this year because the persistence of the problems they represent warrants broad exposure across the federal R&D and policy communities. Readers are urged to review all of these recommendations in light of their own organization's technology needs, R&D programs, and budget priorities. (U)

Active Electro-Optics (U)

The Active Electro-Optics (AEOFG) recommends that the AEOFG accomplish the following over the next year:

1. Continue development of a detailed signature database of proliferation-related materials, particularly biological agents and their precursors;
2. Continue to develop improved plume and effluent atmospheric distribution and dynamic flow models; and
3. Conduct real-world field training and exercises, on the ground and in the air, to validate technologies and techniques, and to improve understanding of the dynamics and evolution of proliferation-related materials in the atmosphere. (U)

Biological Weapons Detection (U)

The Biological Weapons Detection Focus Group (BWDFG) recommends that the BWDFG accomplish the following over the next year:

1. Continue cross-fertilization among national agencies that have different missions but share needs for many of the same technologies to accomplish these missions;
2. Increase emphasis on BW sample collection and processing R&D, with more attention to sample preparation;
3. Give additional emphasis to designing system elements that can be integrated into different collection systems, rather than being limited to single, standalone systems;
4. Increase R&D investigations into modeling and simulation related to the production and weaponization of BW agents; and
5. Conduct further research into small, highly reliable, lightweight power sources. (U)

Chemical Weapons Detection (U)

The Chemical Weapons Detection Focus Group (CWDFG) recommends that the CWDFG accomplish the following over the next year:

1. Increase R&D efforts in modeling and simulation of CW agent production and weaponization; and
2. Expand means for leveraging industry and academia R&D activities to keep abreast of research into relevant emerging technologies. (U)

Fieldable Nuclear Detectors (U)

The Fieldable Nuclear Detectors Focus Group (FNDFG) recommends that the FNDFG accomplish the following over the next year:

1. Explore the use of ultra-low-dose induced gamma-rays for rapid screening of luggage for explosives;
2. Evaluate the use of fieldable nuclear detector technology to locate and identify land mines, particularly those constructed using little or no metal; and
3. Develop the highly portable, inexpensive, sensitive, user-friendly gamma-ray spectrometers required by the US Customs Service to detect and distinguish benign sources of radiation from special nuclear material. (U)

Landmine Detection & Identification (U)

The Landmine Detection and Identification Focus Group (LDIFG) recommends that the LDIFG accomplish the following over the next year:

- The LDIFG should explore further opportunities for synergy with the NPAC TWG focus groups on Active Electro-Optics, Underground Facilities, Spectral Sensing, and Unattended Remote Sensors. (U)

Nuclear Test Monitoring (U)

The Nuclear Test Monitoring Focus Group (NTMFG) recommends that the NTMFG accomplish the following over the next year:

1. Theoretical studies are needed to estimate how efficiently explosive sources just above or below the water surface will couple energy into the SOFAR channel and to estimate signal characteristics;
2. Work is needed on infrasound sensor design and array geometries which minimize the effects of wind and other noise sources;
3. Research is needed in development of radioactive particulate and gas detection equipment that includes self calibration and automatic analysis of the samples taken;
4. Research is needed in all-condition exoatmospheric sensing and discrimination of naturally occurring low-level phenomena as well as ground truth sources for calibration of next generation satellite sensors; and
5. Research is needed to increase the capacity and efficacy of data processing techniques and data authentication features in sensors of all four types of IMS monitoring technologies. (U)

Proliferation Modeling (U)

The Proliferation Modeling Focus Group (PMFG) recommends that the PMFG accomplish the following over the next year:

1. Continue to support efforts to expand and improve INTELINK capabilities that have impact on NPAC issues, and R&D support for web-based dissemination of proliferation-related information, models, tools, and data bases;
2. Continue to support (and secure funds for) R&D for automated security tools that effectively limit system access to specific "communities of interest," and identify and overcome security (compartmentalization) barriers which hinder effective R&D collaboration on NBC-related issues;
3. Continue comparative testing of atmospheric dispersion models to ensure complex plume analysis capabilities are accurately applied to proliferation and arms control-related activities;
4. Reinstate the yearly Conference on ADP Tools for Nonproliferation Analysis as a means for estimating the magnitude of programs and resources associated with proliferation and arms control modeling; and
5. Monitor the health of important "one deep" R&D programs to ensure that no single agency can cancel a program which has broad applications across the community. (U)

R&D Database (U)

The Research and Development Database Focus Group (R&DDFG) recommends that the R&DDFG accomplish the following over the next year:

1. Make an unclassified version of the Technology Needs Subcommittee report available to industry and academia as a means to help to refine their technology submissions and inquiries; and
2. Encourage departments and agencies to procure access to SIPRNET to improve exchange of classified data and communications on NPAC R&D programs. (U)

Spectral Sensing (U)

The Spectral Sensing Focus Group (SSFG) recommends that the SSFG accomplish the following over the next year:

- Across the board, nonproliferation and arms control goals will be better served through research to build a strengthened exploitation capability by: developing improved spectral signatures databases; developing improved automated exploitation algorithms; strengthening the fusion of sensor data and proliferation process models; improving analyst training, expansion, and product development; and building a hardware infrastructure for data handling. (U)

Unattended Remote Sensors (U)

The Unattended Remote Sensors Focus Group (URSFG) recommends that the URSFG accomplish the following over the next year:

1. Establish a central executive function with sufficient resources to provide leadership and coordination of both requirements and sensor development in the unattended sensor community;
2. Conduct more real-world testing of sensor systems and more coordination of testing among sensor developers to demonstrate the operational possibilities of sensors;
3. Encourage the community of unattended sensor developers and users to work more closely with special communications systems providers to identify comprehensive requirements for communications with unattended remote sensors;
4. Foster collaboration between the NPAC TWG and the CMO to secure resources for the development of an unattended sensors technology road map; and
5. Develop programs focused on improved delivery systems for unattended sensors. (U)

Underground Facilities (U)

The Underground Facilities Focus Group (UGFFG) recommends that the UGFFG accomplish the following over the next year:

1. Integrate robotics, tags, and WMD sensors through ATD/ACTD processes;
2. Develop UGF process models to determine data requirements for all aspects of UGFs, from tip-off through characterization;
3. Develop methods, procedures and technologies to provide multi-sensor data integration, event-driven sensor cross-cueing, and semiautomated change detection;

4. Continue investigation of passive EM methods (e.g., power line, spurious emissions) collection systems;
5. Expand exploitation of seismic monitoring for construction status, geolocation, and spoil volume;
6. Expand research methods for collection and analysis of gaseous and other effluents from airborne and satellite systems; and
7. Establish an R&D reserve to take advantage of breakthroughs or new technology. (U)